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BIOLOGY AND ECONOMIC IMPORTANCE OF EVETRIA TAXIFOLIELLA, BUSCK.

By

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Ashland, Oregon

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INTRODUCTION

The results presented in this bulletin, deal with a cone moth (Evetria Taxifoliella[1] Busck), the larvae of which bore in the growing cones of the Douglas fir (Pseudotsuga taxifolia), and destroy the developing seeds. The studies and experiments on which this paper is based were started in 1913 by the senior author at the suggestion of Dr. A. D. Hopkins. The work was continued by both authors during the seasons of 1914 and 1915 at Ashland, Oregon, where the investigations of this and other problems relating to insects injurious to the seeds of western conifers are being conducted.

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The writers are indebted to the members of the other field stations at Missoula, Mont., Colorado Springs, Colo., and Placerville, Calif., for infested material sent from their respective districts; and to the specialists at Washington, D. C. for the determination of numerous specimens submitted.

[1] Order Lepidoptere; family Eucosmidae

RELATION OF SEED PRODUCTION AND REFORESTATION OF DOUGLAS FIR

With the exception of the Sequoia (of California, the Douglas fir or "spruce", as it is commonly known through its range in the Pacific Slope and Rocky Mountains, is the most gigantic tree of the Pacific Coast region, and commercially--it is the most important As it ranges practically through the Northern Pacific coastal region is available locally at a first or minimum cost without the additional transportation charges which are necessitated in connection with imported lumber. Douglas fir adapts itself readily to artificial planting and has been introduced in Europe where it is successfully grown and highly valued for its hardiness, rapid growth and the quality of its wood.

The larvae of Evetria taxifoliella attack and are indigenous to the cones of Douglas fir. As the reproduction of this tree is accomplished only through the agency of the seeds, it follows that the future supply of timber of this species depends entirely upon fertile seed crops. Damage to the seeds, caused by the boring habits of the larvae, lessens the percentage of fertile seeds and consequently has a direct bearing on the reforestation of this tree species.

GENERAL LIFE CYCLE

The larvae of the genus Evetria are primarily resin feeders which attack the tips and branchlets of coniferous trees. Evetria taxifoliella together with Evetria siskiyouana, another species whose habits recently have been determined, are exceptions, in that the attack is confined exclusively to the immature cones.

The cones of Douglas fir mature in one year. At the lowest elevations and in the warmer localities within its range, the first cone buds open the latter part of March. This event continues during April and May, varying according to the climatic influences peculiar to the range, elevations, longitude and latitude of its distribution. The

cones develop rapidly reaching full size in six to eight weeks. They ripen early in August and by September begin to open and shed their seeds. Many of these matured cones fall from the trees during the fall and winter, but often a considerable percentage remains attached to the branchlets until the following spring and later.

The adult moth is inconspicuous, of grayish-brown color with a wing expanse of about 14mm. The wings are marked transversely with irregular bands of gray and brown.

The flight of the moths begins from six to ten days before the opening of the cone buds. The eggs are invariably deposited on the bracts, never on the scales of the cones and the new cones are infested when they are from three to fourteen days old--less than one-half their mature size. The eggs incubate in from fifteen to twenty days, and the young larvae leaving the bracts, as soon as incubation is completed, bore through the scales, and in feeding, channels, which later become involved with resin, through the axis of the cone. During the summer these larvae complete their development and form pupae which become embedded in the resinous channels near the axis of the cones. They now remain dormant overwinter in this position but the following spring, beginning in March, the adult moths emerge and flight begins just before the advent of the new cone crop, which is attacked soon after it appears. A certain percentage of the brood does not emerge the first spring but remains in suspense as pupae during the following summer, fall and winter, to emerge with the advent of the second spring.

The percentage of the brood, which is subjected to a retarded metamorphosis the first year, varies from 6% to 50% of the entire brood, with an average of 10%. This has been established from material kept in rearing both in an insectary and also in the open under normal forest conditions. (Plates I, II)

LIFE HISTORY

The Egg.

The egg measures 1½mm. in lenth and 1mm in width. It is pearly white in color, oblong and flattened, and is attached to the outer surface of a protruding cone bract by a narrow flange which extends entirely around the egg (Pl. II figs 4-5). The development of the embryo imparts a creamy to pinkish color to the egg.

Embryonic Development.

The records indicate that the lenth of the egg stage is between fifteen and twenty days, and that development within the egg progresses slowly. At the end of the fifth or sixth day the outline of the larva shows distinctly, and the egg at this stage assumes a pinkish tinge. Development continues gradually from this stage until hatching, when the color varies from yellow to brown (Table I). A few days before hatching the larva within the egg may be seen distinctly, the thoracic shield which is black being visible as are also the true legs (Pl. II, fig 7).

Hatching

The embryo which up to this time has been curled within the egg now straightens out, bursting the eggshell and immediately bores through the supporting bract and enters the cone through the scale directly below the bract to which the egg was attached.

The Larva

The larva grows rapidly, increasing in length approximately from 2 mm to 4mm within the first three or four

TABLE I. EMBRYONIC DEVELOPMENT OF EVETRIA TAXIFOLIELLA

Dates	Condition of embryo
April 25	Eggs, fresh pearly white
" 26	" " " "
" 27	" turning pinkish
" 28	" " "
" 29	" " yellow
" 30	" " "
May 1	Outline of larvae showing.
" 2	" " " "
" 3	" " " "
" 4	Larvae distinct, eggs turning brown
" 5	" " " "
" 6	" developing, legs distinctly seen
" 7	" " " " "
" 8	Development more complete
" 9	" " "
" 10	Legs and thoracic shield plainly discernible
" 11	" " " " " "
" 12	Larvae fully grown, shield and legs fully formed
" 13	" " " " " " " "
" 14	" straightening in eggs
" 15	" leaving eggshells

Table I. Progressive development of the embryo within the egg. This table was prepared from observations of eggs collected in field and incubated in insectary.

days. When newly hatched the larva is wide, flattened anteriorly, constricted posteriorly, with the true legs plainly discernible, and the thoracic shiled chitinized and black, covering the dorsal portion of the first thoracic segment. The color of the young larva ranges from fawn to brown.

The attack on the cone occurs immediately after hatching, the larva entering the exposed portion of a scale and starting a feed burrow toward the axis of the cone. The first result of cone attack is a flow of resin from the wound made in the scale by the entering larva. The resin flows unchecked as the larva continues to develop and bores deeper into the cone, the mass growing from a minute tear to a large globule which entirely covers the entrance and fills the food burrow through its length (Pl. III fig 4). This probably protects the larva from birds and parasitic enemies.

The larval stage lasts approximately forty-five days; during this time the larva is never quiescent but continues to extent the food burrow through all parts of the infested cone, feeding on scales, tissues and seeds"(Pl. III, figs 3-4).

> The full grown larva is : Approximately 14mm in length, yellowish in color (often with a brownish tinge). The color of the head is brown, mouth parts plack, thoracic and anal shields black, true legs black, body hairs brown. The dorsal portion of the body i yellowish to brown shading to cream on the ventral parts. The tubercles and spiracles are brown.. (Plate II, fig. 3). (Plate III)

Pupa and Hibernation

The pupa is reddish-brown in color, 7 mm in length and 2 mm in diameter (Pl. II, fig 6). It is enclosed in a papery cocoon encased in a mass of resin within the host cone between scales near the axis (Pl. III, fig 5). "The pupal stage lasts approximately 260 days or from about July to April of the following spring when the host cones have developed sufficiently to be attacked by the young larvae."

Adult or Imago

"Labial palpi brown, mottled with fuscous. Terminal joint blackish. Face, head and thorax black, liberally dusted with white. Fore-wings grayish-brown, transversely striated with white and black atoms, at basal third there is a poorly defined, dark brown, black edged, zigzag band across wing, followed by a light gray and white area. Through the middle of the wing from the base runs a poorly defined, brown streak, enlarged into an irregular blotch at the end of the cell. On the costal white intervals, at tornus an oval, white, dusted spot, with a short perpendicular, black line in center. Apical and terminal edge dark golden brown with a black line along the extreme edge before the fuscous cilia. Hind-wing blackish fuscous. Legs fuscous; anterior tarsi annulated with black." [1] Alar expanse: 13-14 mm (Pl. II fig 2).

The species was originally described by August Busk from moths reared from cones collected at Missoula, Montana. Other specimens reared from material collected at Waldo and Ashland, Oregon, were identified as this species by Mr. Carl Heinrich of the Bureau of Entomology. He also identified moths from cones collected in Montana, Washington, Oregon and Colorado as varieties of Evetria taxifoliella. These latter show slight variations in size and color from the Missoula, Waldo and Ashland specimens. The variety which infested the cones from Montana, Washington, Oregon, and California are smaller moths and of darker coloration, otherwise identical with the metatypes. The Colorado specimens emerged from cones collected on Cheyenne Mountain, Colorado. Specimens of this variety are somewhat larger and lighter in color than the moths of Waldo and Ashland rearings, otherwise identical. It is interesting to note that the color pattern and other characters except color and size are constant in both metatypes and varieties. The larvae of either are indistinguishable from the

1. Description of adult is one given by August Busk in describing this species. See bibliography.

others as are habits and character of damage. (Table II)

Length of Life Cycle

"The total length of the life cycle as determined from field observations and from a series of experiments consisting of rearings from infested cones collected in localities thruout the entire range of the insect is approximately twelve months for the first portion of brood; twenty-four and thirty-six months for the second and third portions respectively (Table III.).

Thus the life cycle may be one, two, or three years thruout the range of the insect." (Table III)

Emergence and Flight

"The period of emergence and flight of the adults as determined from numerous rearings made during two seasons is approximately between the dates of March 25 and May 5 at elevations ranging from 2000 to 4000 feet in the vicinity of Ashland, Oregon. From rearing material kept at elevations ranging from 4000 feet to the limit of occurrence of the host, emergence has been recorded as late as the middle of July (Table II.). Occasional stragglers come out earlier and continue later than the dates given. They in no way represent the main portion of the broods."

Retardation

It is a peculiarity of this insect that all of the overwintered pupae do not transform and emerge as adults the first spring. It has been found that a varying percentage of the brood continues as dormant pupae through the spring, summer and winter of the second year. The majority of these retarded pupae emerge at the normal

TABLE II. SEASONAL HISTORY EVETRIA TAXIFOLIELLA

Stage	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Eggs	-----													
	15-20 days													
Larvae	---------													
	Approximately 45 days													
						Hibernation *								
Pupae						----------								
						Approximately 260 days								
Adults flight ovipos ition												---------		
												Approximately 40 days		

* Retarded individuals which constitute the second and third year emergence remain in a state of hibernation for approximately 625 and 990 days respectively.

The above table is a seasonal history of the one year life cycle portion of broods. Prepared from data obtained thruout two seasons.

TABLE III. EMERGENCE AND RETARDATION OF EVETRIA TAXIFOLIELLA BROOD

Hopkins lot No. Locality colld.	Date coll	Cone crop	First year emergence	Second year emergence	Third year emergence
Hopk 10808, Ashland, Oreg.	Oct 2 1913		Mar 20 - Apr 15, 1914. 12 Imagos	Mar 17 - 25, 1915. 3 Imagos	
Hopk 10834, Ashland, Oreg.	Sep 2 1913		Mar 21 - Apr 15, 1914. 53 Imagos	Mar 18 - Apr 2, 1915. 4 Imagos	
Hopk 10882, Ashland, Oreg.	Jan 24 1913		Mar 20 - June 24, 1914. 215 Imagos	Mar 15 - Apr 7, 1915. 15 Imagos	
Hopk 11454, Moffat Creek, Cal	Feb 4 1912	1913	Feb 13 - Apr 17, 1913. 23 Imagos	Mar 19 - Apr 21, 1914, 9 Imagos	Mar 20, 1915. 1 Imago
Hopk 12502, Elliston, Mont.	Apr 10 1913	1914	Apr 12 - 15, 1914. 2 Imagos	Mar 16 - 22, 1915. 2 Imagos	

The above is an illustration of the retardation of Evetria taxifoliella in five lots of cones. It will be noted that approximately 10% of the broods in these lots retarded as pupae. This table was prepared from actual rearings; parasitism and other influences are not considered.

time during the second spring. It has been shown by one lot of breeding material at least, (Table III.) that all these retarded pupae do not emerge the second spring but remain dormant during the third summer and winter and finally emerge the third spring after a dormant period of two and one-half years, and nearly three years after the beginning of development. (Table III)

Without taking into consideration parasitism or other mortality, Table III shows that the percentage of retardation varies from 6% to 50% of the total emergence, with an average of about 10%. All lots recorded in this table were kept in the labratory under the same conditions of temperature and moisture. No attempt was made to maintain a uniform temperature or humidity, but the infested material was exposed to the normal climatic extremes of summer and winter. As a check on this, further material was kept out under forest conditions (Pl. I, fig 1) and the same degree of retardation noted. In fact after the pupae enter the dormant condition the climatic extremes of temperature apparently have no influence upon them except at the period just preceeding and during the opening of the cone buds. There is no explanation why a part of the brood emerge and the remainder remain dormant under similar conditions except that this is a habit essential to the preservation of the species. The same habit has been noted in many other species of insects which are peculiar to the conifers which produce their seed crops irregularly.[1]

Douglas fir does not produce good seed crops annually but there are frequently years of almost complete crop failure. It is evident that if all the individuals of a brood of Evetria taxifoliella emerged during a year of crop failure the species would be practically eliminated thruout the forest areas affected by the crop failure owing to the complete absence of its food supply.

Copulation and Oviposition

Data on copulation and oviposition was secured by

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1 - Bulletin No. 95, U.S.D.A.

TABLE IV. RETARDATION OF EVETRIA TAXIFOLIELLA AFTER FIRST YEAR EMERGENCE

Hopkins lot No. Locality colld.	Date coll	Cone crop	Date examined	No. cones examined	Empty pupal cases, first portion	Live pupae, retarded portion
Hopkins 12535, Mistletoe, Ore.	July 18, 1914	1914	May 26, 1915	41	25	8
Hopkins 12536, Ashland, Ore.	July 17, 1914	1914	Mar 20, 1915	20	18	9

The above table was prepared from data obtained from cutting tests of two lots of cones. The cutting tests were made subsequent to the emergence of the first portion of the broods. The live pupae found indicate the retarded portion, which should emerge the second or third spring. The retarded portion in these two lots is 25.3% of the broods.

collecting adult males and females which emerged between the dates of March 25 and 31 from insectary rearing cages and by liberating them in specially constructed screened cages containing young living cones of the Douglas fir. Strips of blotting paper saturated with sugar solution were placed in the cages and the moths were observed feeding on these at various times. Copulation occured and was continued for a few days after the moths were liberated in the cages.

Oviposition though unfortunately not actually observed, must have occured during the earlier hours of the evening as eggs were found on the cones in the early morning before the moths became active (Pl. III, fig 2). An individual cone may bear a number of eggs, but only one egg is deposited on an individual cone bract. Oviposition in the field under natural conditions has resulted in three and four and occasionally as high as five larvae in each infested cone. The number of eggs laid by a single female was not determined, but it is reasonable to suppose that each female deposits a large number as the caged cones were quite heavily infested. "

Longevity

No records of the longevity of the adult moths under normal outdoor conditions were secured. Adults which emerged March 27, and were liberated in rearing cages lived for about three weeks, the last one dying April 17.

DISTRIBUTION

Evetria taxifoliella has been found in many localities in the Pacific Slope and Rocky Mountain Regions, indicating that its distribution conforms very closely to the natural range of Douglas fir. (See Fig. 1). It has not been reported from any localities outside of this range where Douglas fir is extensively planted.

DAMAGE, AND CHARACTER OF

The damage done to the cones and seeds of the Douglas fir by Evetria taxifoliella consists of the tortuous food channels excavated by the larvae feeding within the cones. These food channels or burrows start at a point on the outer surface of the cone scales where the young larvae attack the cone immediately after hatching (Pl. III, fig 4). At the point of entrance they are so very small as to be almost indiscernible but they gradually become larger as the larvae develop. Terminal portion of burrows excavated by full grown larvae are approximately $2\frac{1}{2}$ mm in diameter. Average length of feed burrows is approximately 45 mm. At the terminal end of the burrows, between two scales, near the axis of the cones, are found the pupal cells which are usually somewhat larger in diameter than the food burrows. The wound to the cone is heavier here than elsewhere, and it results in a large flow of resin which encases the larval cocoon in the pupal cell (Pl. III, fig 5). The larvae do not seem to prefer one part of the cone over another, for they feed indiscriminately through scales, bracts and seeds.

Cones containing only one or two larvae are not appreciably damaged and unless attacked by other insects they develop and mature like normal ones; if the infestation is heavier, with three or more larvae in individual cones, the resultant damage is more noticeable, the effect being an aborted condition and premature withering of these cones. Attacked cones, regardless of the degree of infestation do not prematurely fall from the trees but remain on and fall with the normally developed ones. Immature cones infested with the larvae of Evetria taxifoliella are quite easily determined; the characteristic resin exudation which is almost always present on the surface denotes the active larvae within. In some instances frass thrown out by the larvae from the food burrows adheres to the surface of the cones and assists in indentifying the infestation of Evetria taxifoliella.

Damage follows, both as a direct and indirect result. Directly, those seeds are eaten which are encountered by the larvae in extending the food burrows spirally around the axis of the cones through the basal part of the scales; indirectly, the seeds fail to mature in heavily

infested cones as a result of premature withering and the resulting loss of nourishment.

Percentage of Infestation and Amount of Damage

Table V shows the amount of infestation in seven lots of cones and the percentage of destroyed seed in four of these lots. This is a good average of infestation and damage in the localities represented. Table VII gives the emergence of adult moths from eight lots of cones collected in different localities. This is probably a good average of infestation thruout the insect's range. (Table V) (Pl. IV)

NATURAL ENEMIES

The natural enemies of Evetria taxifoliella are numerous and an important factor in the control of the species. The following primary Hymenopterous parasites, which have been determined by Mr. S. A. Rohwer of the Bureau of Entomology, have been reared from larvae and pupae of this cone moth.

Glypta evetriae Cushman
Zacalochlora milleri Crawford
Tetrastichus species
Ephialtes comstockii Cresson
Itoplectis evetriae Viereck
Exochus species
Pyracmon conocola Rhower

(Tables VI and VII)

ECONOMIC IMPORTANCE

Results of tables show that economically Evetria taxifoliella should be considered a factor in connection

with forestry. As the tree itself suffers no damage, the species confining its attacks and depredations to the cones only, the present forests are in no danger from this insect. But as reforestation by artificial seeding is coming more into favor in the National Forests of the United States and in forests on private estates, the demand for good seed is urgent. Under these conditions cone infesting insects become factors of importance. It is a well known fact that the seed of the Coniferae possess only a moderately high rate of germination; the Douglas fir offers no exception to this rule, the percentage of seed germination is often low, and damage to the seeds caused by the larvae of Evetria taxifoliella contributes to this condition by causing damaged and undeveloped seeds (Table V.).

SUGGESTIONS IN REGARD TO ARTIFICIAL PREVENTION AND CONTROL

The natural enemies of Evetria taxifoliella which are numerous thruout its present range can be relied upon to render fairly successful control under normal conditions. On account of the heavy parasitism by hymenopterous parasites it may be said that Evetria taxifoliella does not interfere to any appreciable extent with the natural reproduction of Douglas fir. Artificial methods of combatting the species owing to excessive cost does not appear to be practical in the extensive North American forests.

Evetria taxifoliella can be introdueed from one locality to another only in cone shipments and not in cleaned seed. This is readily understood when we consider that after the mature seeds fall from the cones the pupae of the insect remains in the cones. Therefore to prevent introduction of this insect into new territory the seed should be extracted from the cones and cleaned previous to shipment.

High Demand for Seed - Spraying Methods Based on Life History

If this insect should become established in well regu-

TABLE V. PERCENTAGE OF INFESTATION AND SEED DESTROYED BY EVETRIA TAXIFOLIELLA IN DOUGLAS FIR CONES

Hopkins lot No. Locality colld.	Date exam.	No. of cones examined	Number seed	Number cones infested	% of cones infested	No. of insects found	Average No. insects per cone	Ave. No. insects per infested cone	Number seed destroyed	Seed destroyed per insect	% of crop destroyed	Stage of insect	Cone Crop
Hopk 12535, Colestin, Ore.	July 18 1914	40	1700	19	47.5	37	9	1.95	555	15	32.65	Larvae	1914
Hopk 12507, Ashland, Ore.	July 7 1914	6	306	6	100.	8	1.33	1.33	93	11.65	30.39	Larvae	1914
Hopk 12584, Mistletoe, Ore.	Nov 25 1914	50	2250	25	50.	35	.7	1.4	455	13.	20.02	Pupae	1914
Hopk 14220, Ashland, Ore.	Dec 2 1915	200	----	60	30.	70	.31	1.17	---	-----	-----	Pupae	1915
Hopk 12536, Ashland, Ore.	July 17 1914	100	4400	66	66.	77	.77	1.65	770	10.	17.5	Pupae	~~1915~~ 1914
Hopk 10874, Ore. Emigrant Creek,	Dec 29 1913	50	----	50	100.	99	1.98	1.98	---	-----	-----	Pupae	1913
Hopk 10896, Missoula, Mont.	Mar 22 1914	20	----	19	95.	32	1.68	1.68	---	-----	-----	Pupae	1913

The above is an estimate of the infestation in seven lots of cones and the percent of destroyed seeds in four lots of these. The data was obtained from actual cutting tests of the lots involved. Only the seeds actually eaten by the larvae were figured. The lots were not expecially selected, they represent the average infestation.

TABLE VI. PARASITISM OF EVETRIA TAXIFOLIELLA BY HYMENOPTEROUS PARASITES

Hopkins lot No. Locality colld.	Date coll	Cone crop	Date examd	Pupae of E. taxifoliella	Parasitic larvae in pupal cases of E. taxifoliella	% of parasitism
Hopk 12597, Ashland, Ore.	Jan 7 1915	1914	Jan 7 1915	26	14	53.85
Hopk 12535, Mistletoe, Ore.	May 26 1915	1914	May 26 1915	6	2	33.33
Hopk 12584, Mistletoe, Ore.	Nov 25 1914	1914	Dec 4 1914	18	15	83.33
Hopk 14220, Ashland, Ore.	Dec 2 1915	1915	Dec 8 1915	57	18	31.58
Unnumbered, Ashland, Ore	Feb 28 1916	1915	Feb 28, 1916	14	6	42.86

The above is an estimate of the percent of parasitism by hymenopterous parasites. The Evetria pupae were collected from the lots listed and were examined individually.

TABLE VII

LOTS OF CONES COLLECTED IN DIFFERENT LOCALITIES

Locality collected	Hopk. No.	Cone crop	No. of cones	Emergence
Missoula, Mont.	10827	1913	20	8
Hilt, Calif	10873	1913	20	22
Missoula, Mont.	10896	1913	20	26
Hellgate, Mont.	11480	1912	20	14
Grants Pass, Ore.	12556	1914	20	9
Garden of the Gods, Colo.	12567	1914	20	3
Cheyenne Mt., Colo.	12574	1914	20	5
Trinity, Calif.	12580	1914	20	4

The above gives the emergence of adult moths from eight lots of cones collected in different localities. The localities given practically cover the insects range thruout the United States. Only the actual emergence from these lots was figured, parasitism and diseases are eliminated.

lated forests, (such as exist in Europe), where intensive forest methods are employed and where the tree is extensively grown for seed and reforestation purposes, spraying is suggested as a remedial measure of control which may be practical on account of the limited supply and value of the seed.

SUMMARY AND CONCLUSIONS

Distribution: Evetria taxifoliella occurs thruout the range of the host, Pseudotsuga taxifolia, as determined by rearings from cones collected in different localities thruout the host's range.

Oviposition occurs in April and May, during a period of about 20 days.

Incubation covers a period of 15 - 20 days, for the greater part in April, May, and June.

Hibernation covers a period of approximately 260 days, or from July or August to the succeeding March or April, or in the cases of the retarded portion of the yearly broods the length of hibernation may cover 12 or 24 months additional time. During hibernation the insect is in the pupal stage.

Imagos emerge during March and April except in the higher elevations where they emerge during May and June.

There is but one generation annually thruout its range. A portion, approximately 10%, of the yearly broods retard as pupae, giving this portion a life cycle of two and, for a very small percent, three years.

Damage consists of: Premature withering of the cones caused by wounds made in them by the developing larvae, and seeds eaten by the larvae. In the locality where this was studied an average of 25.14% of the seed crops of the two seasons 1914 and 1915 was damaged.

Economically Evetria taxifoliella should receive atten-

tion in connection with reforestation.

The natural enemies of Evetria taxifoliella constitute the natural control or check and under normal conditions prevent the insect's attacks from becoming an epidemic.

Cleaned seed only should be shipped into localities where the species has not become established.

Artificial methods of combatting the species is not, owing to prohibitive cost, practical in the North American forests. Artificial methods might be employed advantageously on small tracts where the seed is collected for planting.

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PLATE I. Fig 1. Type of cage used in rearing Evetria taxifoliella under outdoor conditions. These cages were placed at different elevations to record the period of emergence. Fig 2. Type of cage used in the insectary in rearing the species. (Original)

PLATE II. Fig 1. Evetria taxifoliella adults emerging from host cones in which they have hibernated. Fig 2. Imago, Evetria taxifoliella, enlarged. Fig3. Full grown larvae, enlarged. Fig 4. Fresh egg attached to cone bract, enlarged. Fig 5. Egg near completion of incubation, enlarged. Fig 6. Pupae and resin covered cocoons, enlarged. (Original)

PLATE III. Fig 1. Female resting on young cone, probably position assumed in oviposition, enlarged. Fig 2. Young Douglas fir cone bearing egg of Evetria taxifoliella on near center. Fig 3. Nearly full grown larvae in food burrow near tip of cone. Fig 4. Nearly mature cones infested with larvae of Evetria taxifoliella. Cone at left shows external appearance and resion mass at entrance of burrow. Cone at right has been sectioned to show the larval burrow and damage. Fig 5. Sectioned cone showing position of cocoon and pupa. The insect hibernates in this condition. (Original)

PLATE IV. Fig 1. Glypta evetriae, a parasite of Evetria taxifoliella. (a) male, (b) female, (c) parasitized pupae, (d) after emergence of parasite, enlarged. Fig 2. Evetria taxifoliella pupae parasitized by the larvae of Glypta evetriae. (a) pupae containing larvae of parasite, (b) larvae of Glypta evetriae and cocoon of host, enlarged. Fig 3. Evetria taxifoliella pupae parasitized with the larvae of a (undetermined) parasite. Fig 4. Zacalochlora milleri, females. A parasite of Evetria taxifoliella. (Original)